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# THE CHARACTERISTIC BODY POSTURE OF PEOPLE PRACTICING ROCK CLIMBING

**Magdalena Kiełt[1(A,B,C,D,E,F)], Anita Król[1(A,B,C,E)], Andrzej Szczygieł[2(B,D,E)], Jan Bilski[1(A,C,F)]**

[1]Department of Ergonomics and Exercise Physiology, Faculty of Health Sciences, Jagiellonian University Collegium Medicum, Cracow, Poland
[2]Department of Physiotherapy, Faculty of Rehabilitation, University School of Physical Education, Cracow, Poland

## Abstract

**Introduction:** Rock climbing has become not only one of the sports but also a popular form of recreation. The subject of climbing injuries is often discussed, however, the characteristic posture of the climbers and the associated risk of straining and overloading the back is still almost unexplored.

**Objective:** To assess body posture of rock climbers and the factors contributing to changing the shape of curvature of the spine in the sagittal plane.

**Methods:** The study was conducted on 58 person group of men. The subjects were divided into: group I - men trained to rock climbing, group II - men who have not been trained to rock climbing. In a clinical trial the curvature of the spine in the sagittal plane has been rated via the use of Rippstein Plurimetr, Dega test and the Thomas test.

**Results:** It has been shown that men who are training rock climbing for extended periods of time have more chest kyphosis of the spine compared with men who are not. The study confirmed that the effect of the size of the thoracic kyphosis of climbers has: climbing level, training duration and the intensity of your workout. The results of the Dega test have shown the presence of the pectoral muscle contracture in 85% of climbers.

**Conclusions:** Regular practice of climbing affects the formation of anterior-posterior curvature of the spine, and thus the attitude of the body, leading to the emergence of a typical body shape of climbers, namely, the "climber's back".

***Key words:*** *body posture, curvature of the spine, climbing*

## Introduction

In the course of last twenty years, climbing has evolved into a dynamic and deeply interesting sport. For some, it is a form of recreation, for others, a professional sport.

Due to the rapid growth of climbing (the appearance of new technology - the development of new protective equipment and innovative training methods) we have observed an increase in the level of ability [1]. At the same time, climbers began encountering more medical issues. Most of the research conducted in the climber's environment focus on the hand injuries (types and their frequency), and the preventive treatment. Some of the research showed that the most of the injuries are related to the difference between slow adaptation of the ligaments, tendons and capsules and the conformity of muscles. Moreover, climbers that have been training for years often complain about the dystrophy of nails and feet deformation [2-4]. There is surprisingly little information about the overload of the skeleton, spine pains and the change of the posture after years of difficult training.

In extreme sports, competitors aspire to aspire the best possible results, often just within the reach of human possibilities. His organism is forced to repeat the same movements or assume static, often unnatural positions. The overload of the musculoskeletal system and sudden position changes limit the endurance of spine structures and its adaptation capabilities. Overloaded ligaments, tendons and capsules can lead to the changes in the curvature of the spine and result in forming of the body posture characteristic to this sport [5,6].

The main aim of the study has been an analysis of the changes in the spine curvature in the sagittal plane and the assessment of the elasticity of the pectoral and iliopsoas muscles among the subjects.

## Methods

### *Participants*

The research has been conducted on the group of 58 men (mean ± SD age – 24.3 ± 3.67 yrs; height – 1.79 ± 0.7 m; weight – 75.6 ± 10.6 kg) divided in two groups. Group I consisted of men that trained rock climbing (27 subjects), for at least two years and group II (control) of people who did not practice this sport (31 subjects). Subjects with history of either previous spine injury or a diagnosed posture defect and practicing other sports at least 6 hours a week, were excluded from the study.The climbers skill level varied - from the beginners to professionals. For the assessment of climbers (I group) the skill level we have used Cracow's

scale. The division of the levels of low, medium and high has been evaluated by the difficulty of the passed climbing routes OS (on sight). Low level –VI (French grades 6a), as well as medium level - VI.1-VI.2+ (French grades 6b-6c) has been represented by 26% of the respondents and high -VI.3-VI.5+ (French grades 7a-8a) by 48%. Among participant from group I, 52% declared that the are climbing semi-professionally and 48% of the respondents recreationally.

The study has been conducted accordingly with the Declaration of Helsinki, taking the respect for the individual, their right to self-determination and the right to make informed decisions regarding participation in research, both initially and during the course of the research into account. The group has been informed about the goals and the course of the study and each of the respondents has agreed to participate in the study.

***Procedure***

Chosen method of research - diagnostic survey, followed by a clinical examination (the assessment of the spine curvature and functional tests of the pectoral muscles). The author's survey included questions regarding the beginning of the training, preferred type of climbing, the level of ability, type of practice and stretching exercises of choice.

Curvature of the spine in the sagittal plane (kyphosis and lumbar lordosis) was assessed using Rippstein Plurimeter [7]. The study was initiated with setting the plurimeter in the plane of the sacrum, then zeroing the instrument and applying it to the lumbar- thoracic transition, where the value of the lumbar lordosis has been read. Thereafter, without removing the device from the back, it was reseted and transferred to the spinous processes between Th1 and Th3 and the value of the thoracic kyphosis has been read. For each test subject the procedure has been performed twice, and the result was the arithmetic mean of the two measurements.

Next, we performed functional muscle tests (Dega test and a test of Thomas). Test Dega defines "the contracture of the shoulder" [8]. Chosen starting position for the study has been a half-squat with the back against a wall and upper limbs bent to the right angle. Then there has been a bending movement of the upper limbs in the shoulder joints. The researcher observed the process the whole time watching the behavior of the motion of lumbar lordosis and when it began to deepen, stopped the movement. Inability to straighten the back of the subject to the wall upright upper limbs testified shortened pectoral muscles [9,10] and it was noted that the result of the test was a positive.

Thomas test evaluated iliopsoas muscle on the right and left [8]. The starting position for the study was lying back. The examiner put his hand under the lumbar lordosis, controlling the depth, performing at the same time the movement of flexing one of the lower extremities at the knee and hip joints max. to an angle of 130 °. If the execution of this movement forced the second leg to bend at the knee joint, this produced a functional shortened iliopsoas muscle on the side of not performing motion [9,10]. In such a situation on the study was indicated that the test was positive.

***Statistical analysis***

Statistical analysis was performed using R program (version 3.0.0). For all statistical calculations the assumed significance of level *P* equaled 0.05. For the comparison of two groups of variables expressed on a quantitative scale the test was performed the t-Student. For the comparison of more than two groups of independent variables we have used an ANOVA scale. In order to verify the hypothesis that the two variables expressed on a qualitative scale are independent of each other the chi-square test has been used. To determine the strength of the relationship between two variables expressed on a quantitative scale the Pearson`s correlation coefficient "*r*" has been used.

**Results**

Analysis of total collected material showed that regular practice of climbing leads to changes in the body posture. The biggest changes concern the anterior-posterior curvature of the spine, especially the thoracic kyphosis of the spine. The value of thoracic kyphosis for the climbers averaged between 47.65 ± 9.06°, while in the control group it was equal to 28.94 ± 9.43 ° (Fig. 1).

There were, however, no correlation between lumbar lordosis and training for climbing (hours per week). Although when compared to the control group (lumbar lordosis at 19.65 ± 7°) climbers were characterized by deeper lumbar lordosis (21.11 ± 6.05°), the difference between groups was small and did not reach statistical significance. Further analysis showed a significant size difference of thoracic kyphosis in respondents using climbing purely recreationally, when compared to people climbing professionally, in which kyphosis was much greater. These values are presented in Table 1.

The study showed a significant relationship between the level of climbing, and the shape of the thoracic curvature ($P = 0.002$). Climbers who are at the level specified as low (level VI OS), characterized by the mean value equal to 38.86° kyphosis, in the intermediate level the average value of thoracic kyphosis was 47.33°, while those climbing at a high level, crossing the road of VI.3 scale to VI.5 + OS had an average value equal to 52.54° kyphosis.

One of the first factors coming to mind, influencing the change of the shape of the anterior-posterior curvature of the spine is the time and intensity of train-

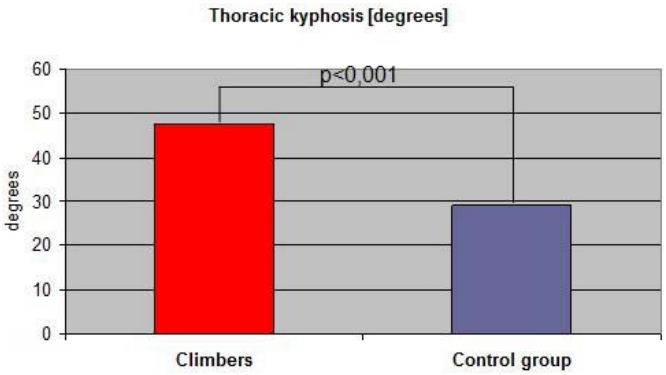


Fig. 1. *The mean values of thoracic kyphosis in the studies groups (n=58)*

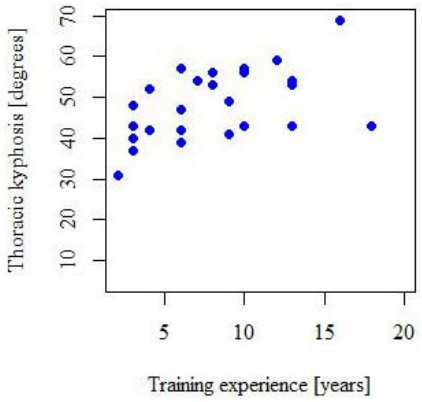


Fig. 2. *The relationship between the magnitude of thoracic kyphosis and training experience (n=27); R=0,547, P=0,04*

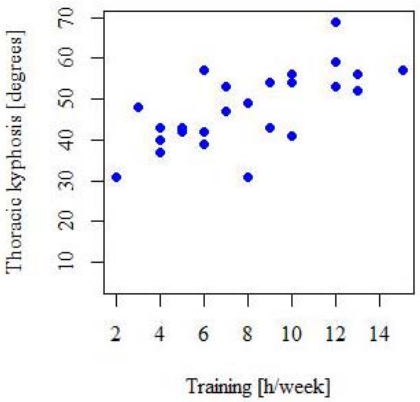


Fig. 3. *The relationship between the magnitude of thoracic kyphosis and intensity of training (n=27); R=0,675, P=0,01*

Table 1. *The mean values of thoracic kyphosis in subjects practicing climbing sports professionally and recreationally*

| Climbing | Thoracic kyphosis[degrees] Average ± SD | Test value (*P*) |
|---|---|---|
| Recreational climbing | 42.83 ± 7.65 | *P* = 0.009* |
| Professional climbing | 51.79 ± 8.29 | |

*t-Student test: $P < 0.05$

Table 2. *Frequency contracture incidence mm. thoracic (right and left) in the studied groups*

| Dega test | Positive | | Negative | | Test value (*P*) |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| Climbers | 23 | 85.19 | 4 | 14.81 | *P* = 0.001* |
| Control group | 4 | 12.90 | 27 | 87.10 | |

*test chi-square: $P < 0.05$

ing climbing. Average length of training of surveyed climbers was 8.3 ± 4.93 years and varied from 2 to 20 years. Average number of hours of training per week was 7.96 ± 3.48 h. While the typical amount of training in the group is from 5 to 10 h / wk. In examining the relationship between the training experience and the size of thoracic kyphosis obtained correlation coefficient of $r = 0.547$, $P = 0.004$ which indicates a strong correlation between these variables. In the case of the intensity climbing workout the correlation coefficient was $r = 0.675$, $P = 0.001$ which also indicates a strong correlation between the number of hours per a week of training and the multiplicity of thoracic kyphosis. Both coefficients are positive, which means that the longer and more intense training, the greater is the kyphosis of the spine.

The next stage of the study was to assess the prevalence of functional shortening pectoral mm. and iliopsoas mm. Compared to the control group, amongst the climbers the contracture of the pectoral

muscles occurred much more often. A strong correlation has been found between training climbing and the occurrence of pectoral muscle contractures ($P$ = 0.001). In fact, in the climber `s group the positive result of test Dega (right and left) was observed in 85% of cases and in the control group - a positive test Dega has only 13% of respondents. These values are presented in table 2. There was no statistically significant correlation between climbing and the incidence of contractures of mm. iliopsoas, $P$ = 0.102. A positive test result Thomas in the control group was observed in 10% of patients, whereas in the group of climbers in 26%. The difference between the groups, although small, may be indicative of a trend.

**Discussion**

Competitive sports and its impact on the formation of the anterior - posterior curvature of the spine is a topic widely discussed by many scientists and doctors. Results of this study confirm that the targeted physical activity leads to changes in body posture. In the literature we can find much more evidence of a relationship between sport and posture. Zeyland-Malawka [6] in her study observed large values of thoracic kyphosis in athletes training handball and fencing. On the other hand, a relatively small inclination of the thoracic spine characterized weightlifters and skaters. Lichota et al. [11] noted that the specific movements made during training used in the sport can influence the type of posture. The highest values of thoracic kyphosis have been noted in volleyball, and handball athletes. This is confirmed by Śleżyński and Rottermund [12], where they have observed that volleyball has generally kyphosis type of attitude associated with thoracic kyphosis clearly marked .The fact that competitive sports affect posture is also confirmed by other authors. Pietraszewska [13] in their study conducted on a group of 15 - year-old football players have observed the occurrence of foot lateral curvature in 29% of trainees. Barczyk [5] also points to a relationship between the occurrence of different types of body posture and specificity of privileges for the sport. For example, a person shall train in competitive judo, cross- medium, and volleyball. In our study, the size of thoracic kyphosis in individuals trained to climb proved to be almost twice higher than in the untrained persons climbing. These are not only changes in the anterior-posterior curvature of the spine. It should be emphasized that the man is a whole, so you can not evaluate and analyze only certain elements of our attitudes.

While watching the climbers it can be noted that they present a specific posture, so-called " climber's back ". The silhouette of a climber has been described, for instance by Förster et al. [1]. The results of their study show that patients regularly training climbing will achieve a specific body posture. According to them, it is characterized by increased thoracic kyphosis of the spine, accompanied by a shortening of the pectoral muscles and lumbar lordosis depth with contracture of the iliopsoas muscles.

The results of the study confirmed that regular training climb leads to the emergence of a typical body shape. In this study the size of thoracic kyphosis in individuals training climbing proved to be almost twice higher than in untrained people. More than that, the results obtained in the study showed a clear relationship between the level of climbing and the size of thoracic kyphosis. Förster observed a similar correlation [1] between the level of climbing and the shaping of a typical silhouettes of climbers. The higher the level, the greater the change in curvature of the anterior-posterior. The higher the level of climbing, the more was observed of a pectoral muscle contracture.

It seems that the source of change in the shape of the spinal curves and shape of specific body postures of climbers is a disturbed muscle balance.

Despite the highly complex rhomboid muscles and the upper trapezius muscle, rectifiers back in relation to the trunk flexors are relatively weak. Increased thoracic kyphosis is also associated with the fact that climbing requires continuous work hands above his head. Drawn up upper limb lead to stretching the muscles stabilizing the shoulder, contributing to the increase in thoracic kyphosis [5]. For disparity also affecting the muscle tone is that climbing involves primarily to the performance of movements associated with a pull-up.

Climbers do not perform in the way of pushing movements. Moreover, the rising movement is predominantly exercised with in and out internal rotation of the arm, which is associated with strong internal rotators of the shoulder joint, an example is latissimus dorsi muscle. On the other hand, are extended external rotators and weak [14].

Tensing of the pectoral muscles, especially the smaller pectoral muscle leads to shortening of their movement. This is confirmed by studies of Förster et al. [1], which gave a positive result, providing the presence of contracture of the pectoral muscles in nearly 70 % of climbers. In our study, the occurrence of contracture in the pectoral mm. was noted in 85% of climbers.

Contracture of the pectoral muscles and hyperactivity pull forward shoulder joints, thereby leading to an increase in the slope of the thoracic spine. In turn, the body reads it as a disturbance and in order to recover the balance starts compensatory mechanisms. An example might be a simultaneous deepening of lumbar lordosis and cervical lordosis at the time of increase of thoracic kyphosis. Climbers obtaining a deeper lumbar lordosis, which has been described

by other authors [1,3] may have been caused only by a compensatory mechanism. Lumbar lordosis depth is often accompanied by contracture of the iliopsoas. An occurrence of the incidence of contracture iliopsoas in the group of climbers was not significantly different from the control group. Muscle contracture iliopsoas occurred in 26 % of climbers and in the control group in 10 % of patients. The presented difference was not statistically significant due to the size of the group, but climbers are exposed to the occurrence of the action of shortening the iliopsoas due to the specificity of training. It seems that results obtained in our study regarding the lack of contracture iliopsoas in the majority of surveyed climbers, maybe associated with a greater awareness of what time climbers and incorporation into training elements stretching exercises to avoid contracture within the hip flexors.

In our study, although it was not possible to examine the cervical, but a preliminary analysis of photographs of the climbers indicates increased cervical lordosis and the position of the head in a large protraction. This is confirmed by studies of Zeyland-Malawka [15], which showed a positive correlation tilt the head forward and the inclination of the upper spine. His research confirmed the generally accepted high kyphosis impact on the setting of the head. Setting the head of climbers in protraction may also be due to a characteristic posture while belaying. While climbing with a partner, belayer must constantly monitor his movements. Cervical spine is then set to the maximum straightening, especially if the partner overcomes area that are heavily strapped. This was pointed out by Peters [3], who studied orthopedic problems occurring amongst climbers.

Climbing involves overcoming loads encountered in everyday life. It is possible that the formation of a specific body shape, protects the climber from injury, adapting the body to perform physical activities demanded from it by climbing. It can therefore be assumed that the characteristic posture of climbers is linked to an adaptive mechanism of the body.

These changes of posture associated with coaching rock climbing involve certain health consequences. In connection with the disturbed balance between the flexors and extensors of the trunk, contraction of the pectoral muscles and significantly increased thoracic kyphosis, lordosis depth cervical and lumbar pain may occur within the shoulder joint (ie: TOS , damage to the rotator cuff , labrum damage type SLAP ), disc herniation of the cervical and lumbar spine [3,14].

Study of the relationship between the shape of the anterior-posterior curvature of the spine and spinal pain in athletes has been prepared by Zeyland-Malawka and Debski [16]. By studying athletes of different disciplines they have confirmed that training in competitive sports is a risk factor for early occurrence of back pain. Furthermore, the above mentioned authors have demonstrated that the use of strength training can accelerate the degenerative process of the spine, but in connection with the strong muscles of the trunk, which are a kind of armor stabilizing people training sports may not initially have pain.

Climbing is often associated with rapid changes in body position when reaching for grip, overcoming hanging platforms and finally hovering on the line in case of a sudden fall from the rock. Excessive non-compensated and anterior-posterior curvature of the spine results in an uneven distribution of forces acting on the surface of the spine, which results in the rapid wear. In addition, the load is transferred also unsuitable for the teenagers articular joints. This all contributes to the change overload and early degenerative changes, which in turn causes pain [16]. Although the expansion of the thoracic kyphosis of the spine is the process of involution is already so large presence of spinal curvatures, at so young and athletic people it should be a signal to increase awareness and education of the proper body posture and corrective training exercises.

People that regularly practice climbing can suffer from the so called "climber's back", which can be described as an increased kyphosis of the spine, contracture of pectoral muscles, possibly an increased lordosis and contracture of iliopsoas muscles as well as increased lordosis in the cervical vertebrae.

It is very important to include corrective exercises and stretching into usual climbing training routine in order to minimise the risk of early appearance of back pain and muscle spasms.

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Address for correspondence:
Magdalena Kiełt
ul. Seweryna 3a/34, 30-632 Kraków
mail: magdalena.kielt@gmail.com
Tel.: 784-961-897

Anita Król: anitakrol1@op.pl
Andrzej Szczygieł: andrzej.szczygiel@awf.krakow.pl
Jan Bilski: jan.bilski@uj.edu.pl